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Post-Inpatient Brain Injury Rehabilitation Outcomes: Report from the National OutcomeInfo Database

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Abstract

This study examined outcomes for intensive residential and outpatient/community-based post-inpatient brain injury rehabilitation (PBIR) programs compared with supported living programs. The goal of supported living programs was stable functioning (no change). Data were obtained for a large cohort of adults with acquired brain injury (ABI) from the OutcomeInfo national database, a web-based database system developed through National Institutes of Health (NIH) Small Business Technology Transfer (STTR) funding for monitoring progress and outcomes in PBIR programs primarily with the Mayo-Portland Adaptability Inventory (MPAI-4). Rasch-derived MPAI-4 measures for cases from 2008 to 2014 from 9 provider organizations offering programs in 23 facilities throughout the United States were examined. Controlling for age at injury, time in program, and time since injury on admission (chronicity), both intensive residential ($n = 205$) and outpatient/community-based ($n = 2781$) programs resulted in significant (approximately 1 standard deviation [SD]) functional improvement on the MPAI-4 Total Score compared with supported living ($n = 101$) programs ($F = 18.184$, $p < 0.001$). Intensive outpatient/community-based programs showed greater improvements on MPAI-4 Ability ($F = 14.135$, $p < 0.001$), Adjustment ($F = 12.939$, $p < 0.001$), and Participation ($F = 16.679$, $p < 0.001$) indices than supported living programs; whereas, intensive residential programs showed improvement primarily in Adjustment and Participation. Age at injury and time in program had small effects on outcome; the effect of chronicity was small to moderate. Examination of more chronic cases (>1 year post-injury) showed significant, but smaller (approximately 0.5 SD) change on the MPAI-4 relative to supported living programs ($F = 17.562$, $p < 0.001$). Results indicate that intensive residential and outpatient/community-based PIBR programs result in substantial positive functional changes moderated by chronicity.

Key words: adult brain injury; outcome measures; rehabilitation

Introduction

The potential impact in improving quality of life, return to work, and community participation of post-inpatient brain injury rehabilitation (PBIR) has increased dramatically in the last 20 years as inpatient rehabilitation stays following acquired brain injury (ABI) have decreased from months to weeks. A number of reviews describe the efficacy of a variety of PBIR programs.[1–6] Nonetheless, often citing limited evidence of effectiveness, third party payers typically limit reimbursement for PBIR. Although many studies of the efficacy of specific PBIR procedures, such as cognitive rehabilitation, are scientifically rigorous (i.e., high internal validity), the relatively small and selective samples involved in these studies may limit the generalizability of findings (i.e., limited external validity). In standard practice, most PBIR is not offered as single procedures in isolation. Rather a PBIR program is typically composed of a highly individualized set of evidence-based services provided by an interdisciplinary or transdisciplinary team that develops a therapeutic relationship with the person served.

Only a small number of randomized controlled trials (RCTs) have been conducted of integrated programs and have demonstrated positive results.[7,8] The heterogeneity both of persons served and the individualized set of interventions challenges the evaluation of the effectiveness of such programmatic interventions through RCTs. Ethical concerns are also relevant because, although some may question the effectiveness of these types of interventions, society at large appears sufficiently convinced of effectiveness to discourage withholding such treatment for experimental purposes.

Observational and comparative-effectiveness studies offer an option for investigating the effectiveness of PBIR interventions at a programmatic level. Such studies involve less rigorous controls than an RCT but arguably have greater external validity and often lead to the same conclusions about the effectiveness and efficacy of an intervention as a parallel RCT.[9] Using the Mayo-Portland

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Adaptability Inventory (MPAI-4) as a primary outcome measure, we and our colleagues have previously completed several such studies of relatively large samples of individuals with traumatic brain injury (TBI), stroke, and acquired brain injury.[10–12] These studies demonstrated significant benefit to participants from intensive interventions provided in residential or outpatient/community-based settings. The benefit from these intensive interventions was apparent relative to naturally occurring comparison conditions, such as partial completion of the prescribed program or supported living interventions designed primarily to help individuals with ABI maintain progress rather than make additional gains. These studies also demonstrated that time since injury (chronicity) at program admission moderated outcome. The effect size of PBIR for those admitted earlier after injury was large (i.e., ∼1), whereas the treatment effect for those admitted more chronically was smaller, but still moderate (i.e., ∼0.5), using Cohen's criteria.[13]

The current study was planned to confirm that intensive PBIR programs result in superior outcomes in abilities, adjustment, and community participation compared with supportive living programs in a retrospective, observational design with a very large national sample of individuals with ABI obtained from the OutcomeInfo database. In contrast to our prior studies, the sample included in the current study was larger and more nationally representative of individuals who received PBIR in the United States. In addition, we aimed to further assess the effects on outcome of possible moderating variables, that is, gender, age, chronicity, and length of intervention.

Method

Participants

Cases initially reviewed for this study included 3294 individuals 18 years of age and older with data obtained on admission to programs contributing data to the *OutcomeInfo* database between 2008 and 2014. Although Rasch analysis is tolerant of missing item data, we elected to exclude cases in which more than one item from an MPAI-4 index (i.e., subscale) was missing because we intended to calibrate each index and the number of items in each index is relatively small. Prior to initial item calibration using Rasch analysis, 15 cases (0.5%) with missing MPAI-4 item data at admission were eliminated from the sample; 4 cases with two missing items (not on the same index) and 64 cases with 1 missing item remained in the sample. All other cases had complete MPAI-4 item data. Following this initial calibration, an additional 32 cases (1%) were eliminated in which the MPAI-4 showed significant person misfit (Person Infit or Outfit ≥3), resulting in a sample of 3247 MPAI-4 admission protocols used in final item calibration. Prior to statistical analyses, 13 cases (0.4%) with more than one missing item per subscale for discharge/second assessments were eliminated; 3 cases with 2 missing items (not on the same index) and 54 with 1 missing item at discharge remained in the sample. In addition, 147 cases (4%) with <6 days or >365 days between the admission and discharge/second assessments were eliminated.

The final sample used in statistical analyses consisted of 3087 individuals (65% male) with a mean age of 46.56 years (SD = 14.415 years) who were an average of 586.78 days (SD = 1788.594 days) post-injury at the time of program admission. These individuals were injured at an average age of 44.19 years (SD = 15.573 years). All cases submitted to the database were identified by contributing providers as having a history of acquired brain injury (e.g., open or closed TBI, stroke, infection, tumor, anoxia). However, detailed diagnostic information was not available on most cases.

OutcomeInfo database

OutcomeInfo is a web-based database system, developed through National Institutes of Health (NIH) Small Business Technology Transfer (STTR) funding, for monitoring progress and outcomes in post-inpatient programs primarily with the MPAI-4. In addition, this database has the capacity to store demographic and injury-related information about participants as well as additional measures specific to each provider. Provider organizations that contribute data to this database do so on a volunteer basis and pay a subscription fee for data management and reporting back to their organizations. Data are managed at a Health Insurance Portability and Accountability Act (HIPAA) approved level of security. Although each contributing organization has complete access to its own data, analyses, such as this one, that combine data across organizations are conducted with anonymity of both cases and organizations.

Data used in the analyses reported here were provided by 9 organizations that operate 23 facilities in 13 states, including Alaska, in the Northeast, South, Midwest, and West. Because of the size and geographic and provider representation, the sample is believed to be highly representative of individuals who are admitted for post-hospital rehabilitation or supported living services after ABI. This population likely differs from the larger population of individuals admitted for acute care after brain injury. For example, Corrigan and colleagues[14] reported that the sample admitted for inpatient brain injury rehabilitation and enrolled in the Traumatic Brain Injury Model Systems (TBIMS) database were younger than individuals admitted to a more general U.S. TBI inpatient rehabilitation sample or for acute hospital care after TBI. As displayed in Table 1, the OutcomeInfo sample tended to have fewer individuals >70 years of age than the general TBI rehabilitation sample and fewer individuals <30 years of age than the TBIMS sample with a larger proportion of those in the 50 to 69 age group than either of the other samples. Gender distribution for the OutcomeInfo sample was similar to that for the general TBI rehabilitation group, which included fewer males than the TBIMS sample.

As part of the development of the database, four major program types were defined through systematic expert inquiry: (1) intensive residential rehabilitation: a goal-directed, therapy-intensive program for individuals with behavioral problems requiring an intensively structured environment with 24-h-a-day onsite supervision and a low staff-to-client ratio; (2) intensive outpatient and community-based rehabilitation: a goal-directed, therapy-focused program for individuals who live in private residences and receive daily to weekly rehabilitation therapies; (3) long-term residential supported living: designed to preserve an optimal level of health and assist participants in their ability to care for themselves, participate in a stable activity plan, and preserve medical, physical, neurocognitive, mood, and behavioral stability in an assisted, supervised residential setting; and (4) long-term community-based supported living: designed to provide ongoing support and structure to individuals who live in private residences to preserve their ability to care for themselves, participate in a stable activity plan, and preserve medical, physical,

Table 1. Age and Gender Comparisons across TBI Rehabilitation Samples

Age (years)	*OutcomeInfo*	*US TBI inpatient rehabilitation without TBIMS*[a]	*TBIMS*[a]
70+	4%	39%	10%
50–69	44%	21%	19%
30–49	35%	20%	22%
<29	17%	20%	39%
Gender (% male)	65%	65%	74%

[a]From Corrigan et al.[14]

TBI, traumatic brain injury; TBIMS, Traumatic Brain Injury Model Systems.

TABLE 2. DEMOGRAPHIC AND MPAI-4 T-SCORES ON ADMISSION FOR FULL COHORT

	Intensive residential rehabilitation	*Intensive outpatient/ community-based rehabilitation*	*Supported living*
Gender (% female)	*20%*	*37%*	*32%*
	Mean (SD)	*Mean (SD)*	*Mean (SD)*
Age at injury (years)	42.68 (13.997)	44.92 (15.306)	27.25 (16.200)
Age at admission (years)	44.57 (13.228)	46.93 (14.514)	40.32 (12.129)
Chronicity (days)	415.54 (1142.014)	472.25 (1525.821)	4087.79 (4305.364)
Days since initial rating	139.27 (82.357)	88.09 (69.119)	161.02 (73.365)
MPAI-4 Ability Index	47.52 (9.369)	50.29 (10.023)	47.12 (9.515)
MPAI-4 Adjustment Index	46.96 (10.848)	50.28 (9.885)	48.55 (10.317)
MPAI-4 Participation Index	47.33 (10.317)	50.23 (9.938)	49.09 (10.308)
MPAI-4 Total Score	46.72 (10.462)	50.31 (9.925)	48.16 (9.803)

MPAI-4, Mayo-Portland Adaptability Inventory; SD, standard deviation.

neurocognitive, mood, and behavioral stability. The most striking difference among these programs is between the intensive rehabilitation programs, which offer patient-centered therapies with a goal of improved functioning, and the supported living programs, which provide structure and support but do not offer therapy designed to improve function. However, the outpatient/community-based intensive rehabilitation programs, which provide therapy and reinforce gains for a limited number of hours per day or per week also differ substantially from the residential intensive rehabilitation programs, which essentially prompt and reinforce therapeutic gains around the clock. Features of each program type are described in more detail in a previous publication.[12] Beyond these broad program types, we did not examine for site differences because our agreement with the provider consortium that contributes data precludes this as well as any other reporting that may compromise patient or program anonymity.

MPAI-4

The MPAI-4[15] consists of 30 items selected to assess commonly occurring limitations after ABI. It is divided into three subscales: Ability Index, Adjustment Index, and Participation Index. Lower scores indicate lesser impairment and limitations. Prior studies have demonstrated satisfactory internal consistency and construct validity,[16–18] as well as concurrent[19] and predictive validity[20–22] for the full measure and its indices. The MPAI-4 has been found to be responsive in the effects of rehabilitation interventions.[10–12,20,23] The MPAI-4 and a manual for its use are freely available on the Center for Outcome Measurement in Brain Injury (COMBI) website (www.tbims.org/combi/mpai).

Data calibration: Rasch analysis

The sample used in this study was significantly larger and arguably more representative of individuals receiving PBIR in the United States than prior samples on which we have based reference values, that is, T-scores.[15] For this reason, we calibrated the admission MPAI-4 item data using Rasch analysis to develop logit scores that meet parametric assumptions for data analysis with the sample of 3279 persons. For this calibration, items 7A (Verbal Communication) and 7B (Nonverbal Communication) were analyzed as separate items rather than combined as in their original presentation. The initial calibration revealed item misfit for a few items, which was remedied by rescoring Audition, Pain, Transportation, and Employment items as suggested by previous Rasch calibrations. As mentioned previously, following this initial calibration, we also eliminated 32 protocols in which Person Infit or Outfit ≥3 suggested an aberrant response pattern. The final calibration on 3247 cases showed good Person Reliability/Separation (0.89/2.86) and Item Reliability/Separation (1.00/38.16) for the

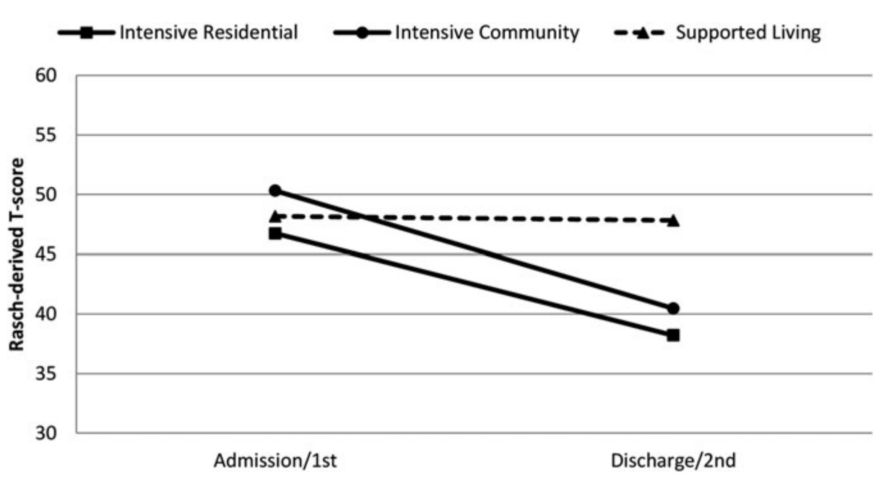

FIG. 1. MPAI-4 Total Score by program type.

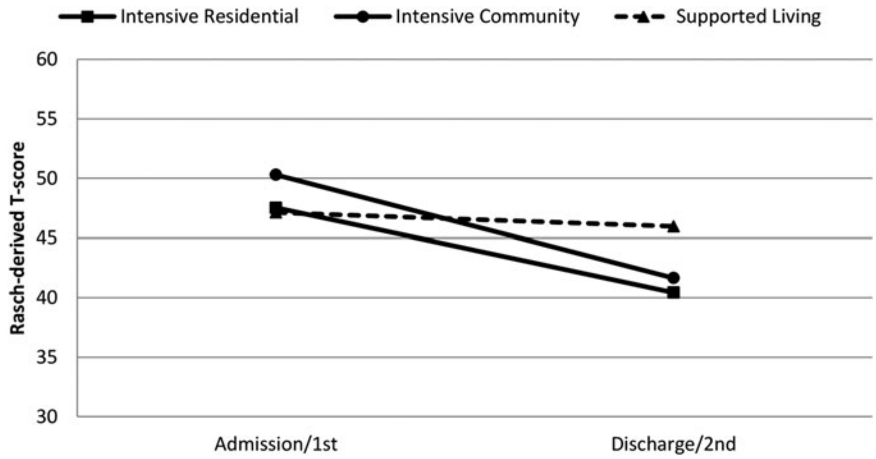

FIG. 2. MPAI-4 Ability Index by program type.

entire scale. Item Infit was acceptable (0.81–1.34) for all items, as was item Outfit (0.80–1.42). Rasch metrics were also acceptable in analyses of each of the three subscale indices, although because of the reduced item number, not as strong as for the entire scale. For the Ability Index, Person Reliability/Separation = 0.81/2.08; Item Reliability/Separation = 1.00/37.48. For the Adjustment Index, Person Reliability/Separation = 0.81/2.05; Item Reliability/Separation = 1.00/34.69. For the Participation Index, Person Reliability/Separation = 0.77/1.81; Item Reliability/Separation = 1.00/29.69. These metrics were comparable to previous calibrations of the measure.

Statistical analysis

Because of the small numbers in long-term residential supported living ($n = 74$) and long-term community-based supported living programs ($n = 27$) these two programs types were combined for comparison with the more intensive program types. Cases in each program type included in these analyses were: intensive residential rehabilitation ($n = 205$), intensive outpatient/community-based rehabilitation ($n = 2781$), and supported living ($n = 101$). Time between injury and admission (chronicity) was highly skewed (skew = 5.567). Consequently, the $\log_{10}$ transformation of chronicity was computed to reduce the skew of this variable (skew of transformed variable = 0.981) and used in all analyses. All MPAI-4 scores were logit values derived from the Rasch analysis converted to T-scores. In some analyses, a small proportion of cases (<1%) were deleted due to missing data for covariates. Because of the small number of cases with missing data, we elected to exclude them rather than attempt imputation. Analysis of covariance (ANCOVA) was conducted to compare MPAI-4 Total and Index T-scores at discharge for the intensive residential and outpatient/community-based rehabilitation programs and at the second evaluation for those in supported living programs because individuals may be in supported living programs indefinitely. To control for status on program admission, admission MPAI-4 Total and Index T-scores were used as a covariates in these analyses. In the initial analyses, other covariates included gender, age at injury, age at admission, and log chronicity. However, gender was not significantly related to outcome and age at admission showed strong collinearity (r = 0.93) with age at injury; consequently, gender and age at admission were not included in general linear models reported in the next section.

Results

Admission status

Participants in each of these three programs types differed on admission in gender ($\chi^2 = 21.948$, $p < 0.001$), age at admission ($F = 12.449$, $p < 0.001$), age at injury ($F = 66.488$, $p < 0.001$), $\log_{10}$ chronicity (time since injury; $F = 190.011$, $p < 0.001$), days since

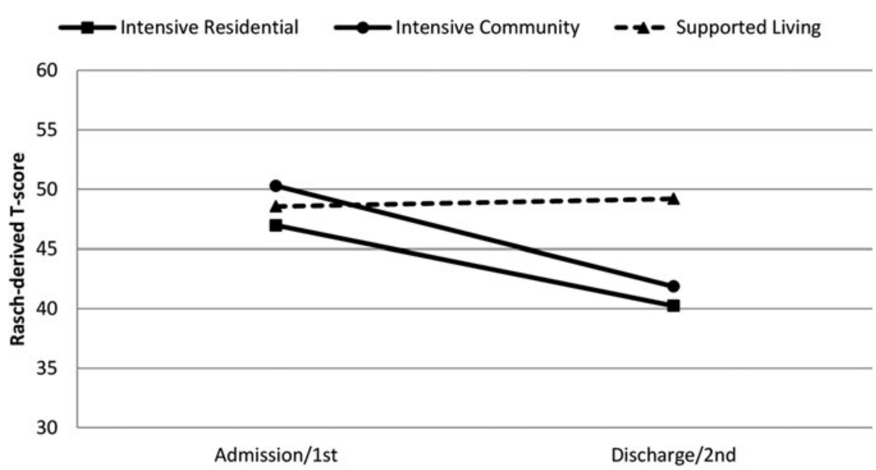

FIG. 3. MPAI-4 Adjustment Index by program type.

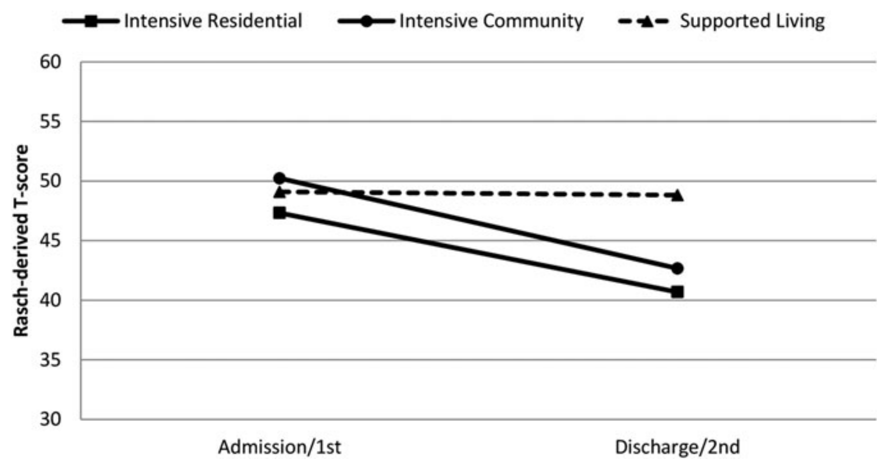

FIG. 4. MPAI-4 Participation Index by program type.

initial rating ($F = 98.464$, $p < 0.001$), and MPAI-4 Ability Index ($F = 11.733$, $p < 0.001$), Adjustment Index ($F = 11.714$, $p < 0.001$), Participation Index ($F = 8.498$, $p < 0.001$), and Total Score ($F = 14.171$, $p < 0.001$). Table 2 displays summary statistics for these variables. The proportion of women in residential rehabilitation programs was lower than for other program types. Post hoc comparison of program types with Fisher's least squares difference (LSD) test showed that those admitted to supported living programs tended to be younger at time of injury and more chronic on admission than those in intensive programs. Age differences on admission were not as dramatic; however, those in supported programs continued to be younger. Days since initial rating (i.e., time between admission and discharge ratings for intensive rehabilitation groups and time between first and second rating for supported living group) was shorter for those in intensive outpatient/community-based programs than for those in intensive residential, which was shorter than for those in supported living programs. Total MPAI-4 Score on admission indicated that participants in intensive outpatient/community-based programs had more impairments and limitations than those in intensive residential or supported living programs. More specifically, intensive outpatient/community-based program participants had more Ability impairments than those intensive residential or supported living programs and greater limitations in Adjustment and Participation than those in intensive residential rehabilitation programs. (See Table 2 and Figs. 1–4).

Outcome comparisons

After controlling for MPAI-4 admission scores, age at injury, days since initial rating, and log chronicity, discharge/second assessment MPAI-4 scores differed significantly among programs for Total Score ($F = 18.184$, $p < 0.001$), Ability Index ($F = 14.135$, $p < 0.001$), Adjustment Index ($F = 12.939$, $p < 0.001$), and Participation Index ($F = 16.679$, $p < 0.001$; see Figs. 1–4). Although the covariate, age at injury, was significantly related to outcome and was retained in the model, the effect size for this variable was very small (partial $\eta^2 = 0.003$–0.006) in predicting the MPAI-4 Total and Index Scores at discharge/second assessment. The effect size for time in program (days from initial to discharge/second assessment) was also small (partial $\eta^2 = 0.006$–0.025). The effect size for log chronicity, however, was small to medium (partial $\eta^2 = 0.078$–0.113), and as might be expected, the effect size for MPAI-4 score on admission was very large (partial $\eta^2 = 0.469$–0.620). Post hoc LSD comparisons indicated intensive outpatient/community-based programs

Table 3. Demographic and MPAI-4 T-scores on Admission for Chronic Cohort

	Intensive residential rehabilitation (n = *36*)	*Intensive outpatient/ community-based rehabilitation* (n = *516*)	*Supported living* (n = *79*)
Gender (% female)	*11%*	*44%*	*37%*
	Mean (SD)	*Mean (SD)*	*Mean (SD)*
Age at injury (years)	36.83 (13.946)	37.97 (15.915)	26.43 (14.881)
Age at admission (years)	42.36 (12.604)	44.34 (14.417)	40.58 (12.003)
Chronicity (days)	1935.67 (2163.361)	2193.40 (2982.807)	5177.85 (4270.216)
Days from admission to discharge/second assessment	173.50 (76.928)	131.01 (89.302)	171.59 (74.567)
MPAI-4 Ability Index	47.55 (9.84)	50.34 (11.493)	46.97 (9.865)
MPAI-4 Adjustment Index	51.21 (13.000)	53.18 (11.425)	49.17 (10.107)
MPAI-4 Participation Index	46.70 (10.602)	49.28 (10.881)	49.80 (10.724)
MPAI-4 Total Score	47.77 (11.653)	50.71 (11.075)	48.40 (9.834)

TBI, traumatic brain injury; TBIMS, Traumatic Brain Injury Model Systems.

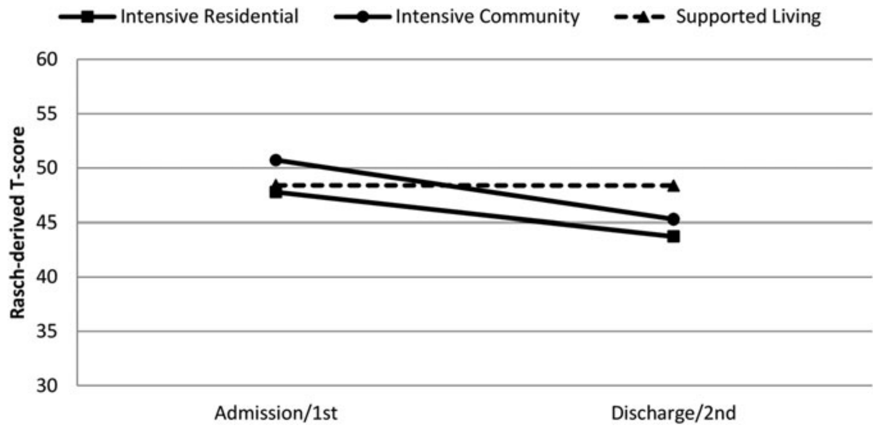

FIG. 5. MPAI-4 Total Score by program type for participants admitted >1 year post-injury.

demonstrated better overall outcomes on the MPAI-4 Total Score and specifically on the Adjustment Index than intensive residential programs, which in turn showed more improvement than supported living programs. Intensive outpatient/community-based programs resulted in greater reduction in Ability impairment more than intensive residential or supported living programs. Both intensive residential and outpatient/community-based rehabilitation programs showed more improvement on the Participation Index than supported living programs. However, the effect sizes for comparisons among treatment types were small (partial $\eta^2 = 0.008$–0.012).

Outcomes in chronic cases

To examine outcomes in more chronic cases at a time when physiological recovery has clearly ended and consequently chronicity would not as prominently affect outcome, outcome analyses described above were repeated for only those participants admitted to programs more than one year post-injury. Demographic and admission MPAI-4 data for this chronic cohort are shown in Table 3. Cases available for these analyses were greatly reduced: intensive residential programs ($n = 36$), outpatient/community-based programs ($n = 516$), and supported living programs ($n = 79$). Controlling for admission MPAI-4 scores, age at injury, $\log_{10}$ chronicity, and days since initial rating, ANCOVA showed significant differences among the three program types for the MPAI-4 Ability Index ($F = 7.802$, $p < 0.001$), Adjustment Index ($F = 13.914$, $p < 0.001$), Participation Index ($F = 14.056$, $p < 0.001$), and Total Score ($F = 17.562$, $p < 0.001$) at discharge/second assessment. Post hoc LSD comparisons showed intensive residential and outpatient/community-based programs had superior outcomes to supported living programs on MPAI-4 Total Score and each of the Ability, Adjustment, and Participation Indices. Outpatient/community-based programs showed more improvement on the Adjustment Index than intensive residential or supported living programs. The covariates age at injury and, as expected, chronicity did not account for significant variance on the outcome variables for this more chronic cohort. There was a significant relationship of days since initial rating to discharge/second assessment. Participation Index although the effect size was small (partial $\eta^2 = 0.014$). In general, effect sizes for program type were greater than in the analyses of the full cohort (partial $\eta^2 = 0.024$–0.053). However, mean score change from admission to discharge/second assessment tended to be more on the order of 0.5 SD (see Figs. 5–8).

Discussion

Results of this study provide further confirmation of the benefits of PBIR in a large nationally representative sample of adults with ABI admitted for PBIR or supported living services. The cohort of over 3000 individuals with ABI involved in intensive residential or outpatient/community-based rehabilitation programs showed substantially improved ability, adjustment, and community participation over the course of rehabilitative treatment. Improvement on MPAI-4 measures was about 1 SD, which is equivalent to an effect

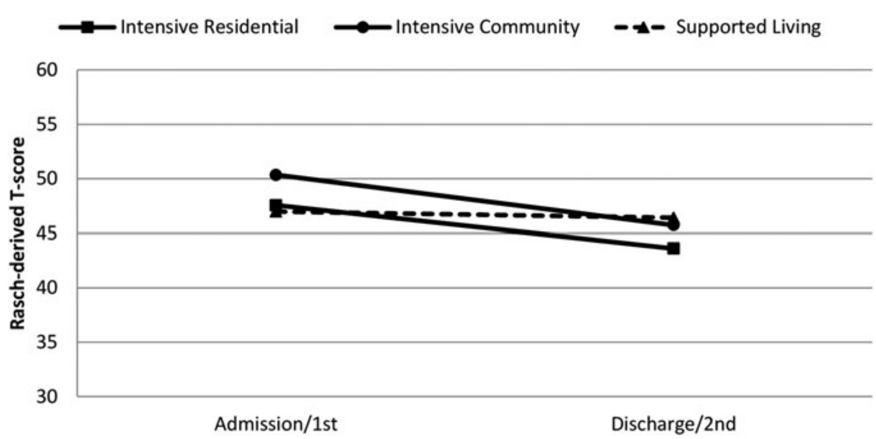

FIG. 6. Ability Index by program type for participants admitted >1 year post-injury.

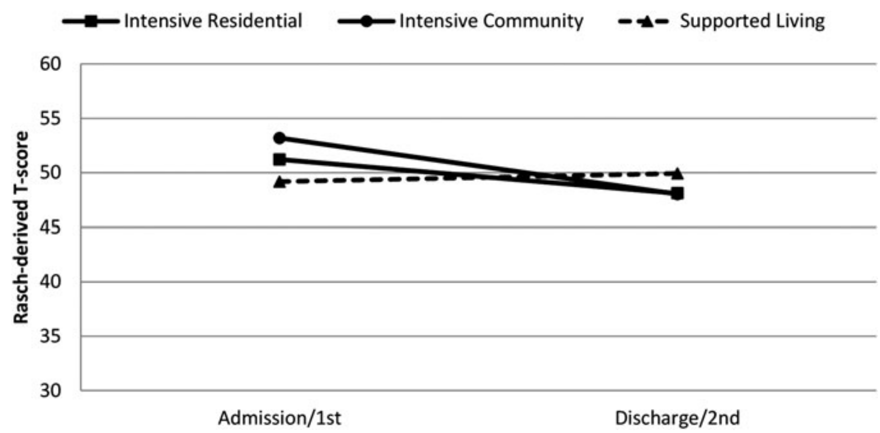

FIG. 7. Adjustment Index by program type for participants admitted >1 year post-injury.

size of about 1, a large effect. Although definitive determination of the Minimal Clinically Important Difference (MCID) for a measure is complex, a change on a measure equivalent to 0.5 SD has been suggested as a preliminary estimate of the MCID.[24] Changes reported here both for the chronic and entire cohort meet or exceed that minimal standard. In contrast, a comparison group that received only supported living services showed no change over a slightly longer period of time. Although it does not have the potency of a rigorously and prospectively designed control condition, this comparison condition offers a control for some nonspecific factors, such as, regular attention from professional staff, help in structuring activities, and belonging to a program.

There were significant differences between those admitted to supported living versus intensive rehabilitation programs, although these differences did not necessarily suggest an advantage for those participating in intensive rehabilitation. For example, the group that received intensive outpatient/community-based rehabilitation not only were the most severely and pervasively disabled on admission but also showed the most favorable outcomes. As might be expected, those in supported living programs tended to be more chronic, very likely because many were admitted to such programs after progress in a more intensive program had plateaued. This raises the possibility that the lack of change from admission to second assessment for those in supported living programs is attributable to these individuals being selectively admitted to such programs because the prospect of further progress in rehabilitation was minimal. However, an examination of only those individuals who were ≥1 year post-injury indicated that intensive rehabilitation programs result in significant gains even many years post-injury in comparison with supported living programs. In the analysis of the cohort who were admitted to programs >1 year post-injury—and in contrast to the analysis of the entire cohort—participant age at injury and chronicity no longer showed a significant relationship to outcome. Concomitant with the loss of an effect for these covariates, the effect size for program type increased, suggesting that the differential outcomes are to some degree due to program type and not only participant characteristics, physiological recovery, or nonspecific effects.

Consistent with our previous studies, gains made by the more chronic group were only about half as great as for those admitted to intensive programs within the first year post-injury. The significant but less impressive gains made by those admitted to intensive programs more chronically compared to dramatic improvement by those admitted earlier post-injury offers further support for the maxim of early intervention. Although early spontaneous recovery may contribute to the gains made by those admitted to rehabilitation more acutely, it also seems reasonable to surmise that introducing rehabilitation that prevents social isolation and the development of additional psychological and social problems enhances recovery. For those not fortunate enough to be involved in rehabilitation shortly after acute hospital care, the development of such comorbidities would in turn be expected to interfere with progress in rehabilitation in the more chronic phase.

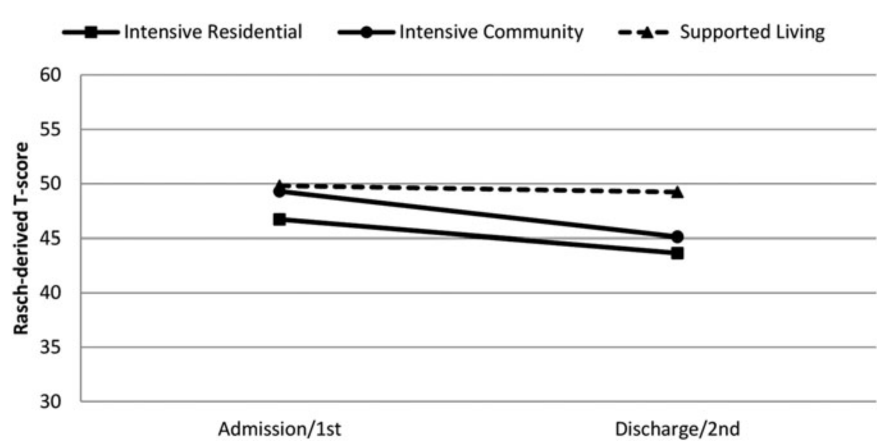

FIG. 8. Participation Index by program type for participants admitted >1 year post-injury.

Other interesting differences among those admitted to the various program types emerged in our analyses. Those in supported living programs were also younger, possibly finding their way into such programs in the absence of a significant other or other secure family structure to assist them; however, there is no detailed information about family situation in the database. The relatively small number of individuals participating in supported living programs no doubt represents the difficulty with which funding is obtained for such services. Participants in intensive outpatient/community-based rehabilitation were more impaired overall on admission but also obtained the best outcomes despite shorter time spent in such programs. This group demonstrated superior outcomes both for the entire cohort as well as for the chronic cohort that was admitted ≥1 year post-injury. This was by far the largest group examined and demonstrates the benefit of relatively low-cost intensive rehabilitation services efficiently delivered in a community setting.

Nonetheless, there are individuals with ABI who may require greater supervision and consistency of intervention. Such individuals are typically admitted to intensive residential rehabilitation programs. Although the group admitted to intensive residential programs demonstrated less overall disability on admission than the intensive outpatient/community-based group, one suspects that these may have been cases that tended to be more treatment resistant or required 24-h supervision because of concern about their safety or that of those around them. However, other factors may also have contributed to residential placements, such as, lack of locally available outpatient/community-based services or limited family capacity to provide consistent supervision. Fewer women were admitted to intensive residential programs than to other programs possibly because they may be perceived to be more easily managed in family settings. In addition to factors discussed previously, selection of program type may also have been influenced by variables that we were unavailable to us for analysis, such as, geographic availability of a particular program type and socioeconomic status of the participant and their family. In short, assignment to treatment condition cannot be considered random or quasi-random. We also did not have available data to examine such factors as degree of case management or neuromedical/therapeutic supervision. However, prior studies suggest that measuring intensity of service is elusive and that outcome is not related simply to number of hours of service provided but may be a function of a complex of factors including time in therapy, timing of therapy relative to patient readiness, and therapeutic engagement.[25,26]

The lack of information about type and severity of injury may also be seen as a weakness of this study. However, we would contend that the admission assessment of disability with the MPAI-4 captures the effects of these injuries, as well as possible pre-injury limitations and additional limitations due to documented or undocumented comorbidities, and hence better represents participant status on admission than any of these variables in isolation. Clearly the best predictor of outcome is admission status. Those with severe disability on admission may make substantial progress in rehabilitation. However, their level of disability at discharge may still be more than those who entered the program with less disability but made the same degree of improvement. The lack of a prospective, tightly controlled design represents another limitation, primarily to internal validity. Conversely, the sample included is a very large, real-world sample that supports the external validity and generalizability of our conclusion that those involved in early intensive residential or outpatient/community-based rehabilitation show substantial benefit in improved abilities, adjustment, and community participation over the course of such treatment. Future studies planned with this cohort will seek to determine the MCID for the MPAI-4 more definitively. As is apparent from the previous discussion, it also seems likely that outcome is related to participant characteristics and very possibly to an interaction between these characteristics and program type. Further study of this dataset is planned to attempt to identify what type of individuals (based primarily on their disability profile) benefit most from intensive residential and outpatient/community-based rehabilitation programs relative to supported living programs.

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Author Disclosure Statement

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